# PUNCHING TOOL

## FIELD OF THE INVENTION

The invention relates to a punching tool having a die plunger guided during axially displacement but fixed against relative rotation, in a guide bushing and having a bore in the front end, in which a punching die can be axially fixed by its shaft which is provided with an annular groove, by means of holding elements which releasably engage the annular groove.

## BACKGROUND OF THE INVENTION

Such a punching tool with releasable locking against axial relative movements between the punching die and the die plunger is known from French Patent No. 2 641 486 A1. There, three screws acting as holding elements, which are radially screwed into corresponding transverse threaded bores in the die plunger, engage with rounded, hardened ends an annular groove in the shaft of the punching die. The screws fix the punching die axially on the die plunger and absorb the forces occurring on the punching die in the course of the punching stroke, as well as during the return stroke, and transfer them to the die plunger. Since in this case the stressed surfaces are very small, the known punching tool cannot absorb large punching forces. Moreover, changing of the

punching tool is very awkward, since several screws must be removed and screwed back in again to accomplish this.

Furthermore, punching tools with releasable locking against relative rotating movements between the punching die and the die plunger are known from U.S. Patent No. 2,172,272 and German Utility Model 92 18 677. Such locking to prevent movements in both directions of rotation is necessary because the punching die is connected with the die plunger by a screw thread, which transmits the axial loads occurring during punching from the punching die to the die plunger and permits a compensation of the total length of the punching die and the die plunger after re-grinding. To prevent a relative rotating movement of the two threaded elements, and therefore a change of the total length, the exterior thread is cut by several axial longitudinal grooves distributed over the circumference, and a pointed pin, seated in a transverse bore of the screw thread element with the interior screw thread, is pushed into one of the longitudinal grooves by a spring washer. In the mentioned utility model, the pointed pin is embodied as one piece with the spring washer and is prevented from a radial backing movement out of the longitudinal groove in that the bore wall of the guide bushing blocks a widening of the spring washer. Basically the locking must absorb the loads in both directions of rotation. If the spring washer is outside of the bore in the guide bushing, a relative rotation of the screw thread elements is possible, wherein it is necessary for releasing and renewed connecting of

the punching die with the die plunger to overcome the rotatory locking several times in the course of each revolution.

## SUMMARY OF THE INENTION

The object of the invention is based on creating a punching tool of the type described which provides secure locking against axial relative movements between the punching die and the die plunger, which permits a simple and rapid separation of the punching die from the die plunger, and wherein the large forces occurring in the course of the punching stroke are kept away from the holding members by a one-sided relief of the locking.

The above object is attained in accordance with the present invention in that during the punching stroke the punching die rests against a front face of the die plunger and can be axially fixed in place by means of one or several holding members in the form of snap-in balls, each of which is seated in a transverse bore in the front end of the plunger, and which are maintained in engagement with the annular groove by means of a spring washer whose outer diameter is less in the engagement position than the inner diameter of the guide bushing and which can be widened to a diameter greater than the inner diameter of the guide bushing when the punching die is removed from the die plunger.

The novel punching tool initially offers the advantage that the strong loads during the punching stroke are transmitted via the front face

of the die plunger, so that the holding members need not be correspondingly strong. The snap-in balls and their guide faces are only stressed by the considerably lesser forces during the return stroke of the punching die. The spring washer also needs to exert only a minimal spring force on the snap-in balls in order to prevent the punching die from falling out of the bore in the die plunger outside of the guide bushing. Therefore the punching die can be easily separated from the die plunger or, vice versa, pushed into the bore in the front end of the die plunger and locked there. Regardless of the small or minimal spring force with which the spring washer pushes the snap-in balls into the annular groove, the proposed locking against axial separation of the punching die from the die plunger is absolutely dependable as long as it is provided by means of a suitable selection of the diameters that the snap-in balls still engage the annular groove when the spring washer rests against the bore wall of the guide bushing.

To keep axial play in the locking as low as possible, it is provided in a preferred embodiment of the invention that in the engaged position the outer diameter of the spring washer is only minimally less than the inner diameter of the guide bushing.

Also, in view of dependability of the locking, the spring washer is usefully made of steel. It has furthermore been shown to be advantageous if the spring washer is seated in an annular groove in the circumferential surface of the die plunger which crosses the center

longitudinal axes of the transverse bores and is only slightly wider than the diameter of the spring washer in axial section.

In the preferred embodiment of the invention, the axial support of the forces during the punching stroke is provided in that the shaft of the punching die is formed with a flange or collar whose rear rests against the front end face of the die plunger. However, alternatively the rear end face of the shaft of the punching die could also rest on the bottom of the bore in the front end of the die plunger. The front end face of the die plunger enclosing the bore on which the back of a flange could be axially supported on the die plunger, as well as the bottom of the bore in the front end of the die plunger, each constitute a portion of the entire front face of the die plunger, which is also understood here to be all faces facing forward toward the punching die, provided they are not created by undercuts.

To assure axial freedom from play, in a useful embodiment of the invention the distance between the transverse plane in which the center longitudinal axes of the transverse bores are located, and the front end face of the die plunger, or of the bottom of the bore, is of such a size in relation to the distance between the central transverse plane through the annular grove and the back of the flange, or of the rear end face of the shaft of the punching die, that the punching die can be pressed axially against the die plunger by means of the spring-loaded snap-in balls.

In many applications, the contour of the cutting edge of the punching die has a shape which differs from a circle. It is necessary in such cases to maintain not only the die plunger, but also the punching die, at a defined angle of rotation with respect to the central longitudinal axis of the bore of the guide bushing. To this end, the shaft of the punching die is preferably provided behind the annular groove with an open elongated groove which is open at the rear end of the shaft, into which a transverse pin matching the width of the longitudinal groove and seated in the die plunger can be inserted into the bore in the die plunger when the punching die is inserted. In this case the transverse pin preferably projects radially outward from the die plunger into a longitudinal groove of matching width in the guide bushing. In this way the die plunger is oriented in the circumferential direction and fixed in place with respect to the guide bushing, the same as the punching die is fixed in place with respect to the die plunger.

## BRIEF DESCRIPTION OF THE DRAWINGS

The invention will now be described with respect to preferred embodiments thereof wherein:

Figure 1 is a longitudinal sectional view through the front end of a guide bushing containing the features of the present invention;

Figure 2 is a cross sectional view taken along line 2-2 of Figure 1; and

Figure 3 is a perspective view of an element of Figures 1 and 2.

## DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

An exemplary embodiment of the invention will be explained in greater detail with reference to the accompanying figures. Figure 1 shows a simplified longitudinal section through the front end of a guide bushing and of a die plunger guided therein, as well as a punching die connected thereto.

The guide bushing 10 can be a conventional guide bushing such as is used, for example, in connection with a conventional punching press. The guide bushing 10 is inserted into the tool receiver of the punching press in an angle of rotation positioned in relation to its central longitudinal axis, which is for example determined by an exterior longitudinal groove in the guide bushing, and is fixed in this position. It is not important for the present invention how the upper end of the guide bushing is connected with the other components of the punching tool and whether an exchangeable stripper plate is attached to the lower end. In the exemplary embodiment shown, for the sake of simplicity the portion of the punching tool used as a stripper is shown as being of one piece with the guide bushing 10.

A die plunger 12 is guided during axial displacement, but fixed against rotation relative to the guide bushing 10. Die plunger 12 transmits the pressure and pulling forces exerted on its upper end for performing the punching stroke and the return stroke. The fixation against rotation relative to guide bushing 10 takes place in the customary way by means of a transverse pin 14 seated in the front area of the die plunger 12, which projects radially and wherein its front end slides in a longitudinal groove 16, which matches its width and is open at the end of the guide bushing 10. The longitudinal groove 16 can be the same longitudinal groove which fixes the angle of rotation of the guide bushing with respect to the punching press, but it can also be a separate groove independent of the former.

The die plunger 12, which is circular in cross section, is provided at its front end with a concentric bore 18, which is used for receiving the rear of shaft 20, which matches the diameter of a punching die identified as a whole by 22. The latter moreover has a front shaft 24 whose cross section, for example circular or polygonal, corresponding to the holes to be punched, is provided with a flange or collar 26 in its central area, and in the assembled state rests with its back against the front end face of the die plunger 12 during the punching stroke, so that the punching force is transmitted from the die plunger 12 to the punching die 22 through these cooperating faces.

To assure fixation in an angle of rotation which is defined with respect to its central longitudinal axis and is important in connection with a punching die 22 of polygonal or non-circular cross section of the front shaft 24, the transverse pin 14 is arranged in such a way that it projects radially inward into the bore 18 near the inner end of the latter. The rear shaft 20 of the punching die 22 is provided on at least one location of its circumference near its rear end with a longitudinal groove 28, which matches the width of the transverse pin 14 and is open at its outer end. The punching die 22 must be introduced into the bore 18 in such a way that the inner end of the transverse pin 14 enters the groove, or a defined longitudinal groove 28, and in the engaged position maintains the punching die 22 fixed against relative rotation with respect to the die plunger 12.

In the course of inserting the punching die 22 into the bore 18, three snap-in balls 32, each of which is seated in a transverse bore 30 in the front end of the die plunger 12, snap into an annular groove 34 in the rear of shaft 20 of the punching die 22 immediately prior to reaching the axial end position in which the rear of the collar 26 rests against the front end face of the die plunger 12. The snap-in balls 32 are urged radially inward by a spring washer 36 made of steel, which surrounds them but, because of a slight inward taper of the transverse bores 30 in the area of their outlet into the bore 18, they are prevented from falling out of the transverse bores 30 after the punching die 22 has been pulled out of the

bore 18 of the die plunger 12. The axial position of the transverse bores 30, whose diameter matches the diameter of the snap-in balls 32, in relation to the front end face of the die plunger 12, and the axial position of the annular groove 34 in relation to the rear face of the collar 26, have been selected to be such that in the assembled state represented in the figures the collar 26 rests against the front end face of the die plunger 12, and at the same time the snap-in balls 32 enter as far as possible into the annular groove 34. In this position the spring washer 36 takes up a substantially concentric position with respect to the punching die 22 between the snap-in balls 32 and the bore wall of the guide bushing 10. In this case the radial distance between the spring washer 36 and the bore wall should be as short as possible in order to minimize a radial deflection movement of the snap-in balls 32 and a corresponding axial movement of the punching die 22 with respect to the die plunger 12 during the transition from the punching stroke to the return stroke. The spring washer 36 is seated in an annular groove 38, the width of which matches its height, in the die plunger 12, whose central plane coincides with the transverse plane in which the central longitudinal axes of the transverse bores 30 are located. The spring washer 36 is preferably a spiral spring washer having several turns, as best shown in isolation in Figure 3.

As long as the front end of the die plunger 12 is located in the guide bushing 10, the punching die 22 is maintained unreleasably in the

bore 18 by the snap-in balls 32. The balls 32 cannot radially exit the annular groove 34, because they would have to widen the spring washer 36 beyond the limits of its radial expansion to do this. But the spring washer 36 can only be minimally widened until it engages the bore wall of the guide bushing 10. Thus, in the assembled state the fastening arrangement shown and described here represents an absolutely dependable, positive locking, which is relieved at one end, so that large punching forces can also be transmitted.

On the other hand, the described fastening arrangement permits a very rapid and simple removal and exchange of one punching die 22 for another. As soon as the front end of the die plunger 12 has been removed from the guide bushing 10, the spring washer 36 maintaining the snap-in balls 32 in their inner end position can easily be deflected radially outward when the punching die 22 is pulled out of the bore 18 by a manual pull and in the process the snap-in balls 32 are radially urged out of the annular groove 34. In the process the spring washer 36 maintains the snap-in balls 32 in their transverse bores 30 and, following the removal of the punching die 22, urges them into their radially inner end position in the tapered inner outlet opening of the transverse bores 30. Also, during insertion of a new punching die 22 into the bore 18 outside of the guide bushing 10, the snap-in balls 32 can initially be deflected radially outward while the spring washer 36 is widened, before they snap into the annular groove 34 directly ahead of reaching the represented end

position, in the course of which the diameter of the spring washer 36 is reduced until it again fits into the bore of the guide bushing 10.

It is understood that, differing from the above description of the exemplary embodiment, more or fewer than three snap-in balls 32 can be provided. With smaller diameters of the die plunger 12 in particular it could also be imagined that the punching force is not transmitted via a collar 26, but instead via the rear end face of the punching die 22. In this case that part of the front face of the die plunger 12 formed by the bottom of the bore 18 would have to be designed in such a way that a sufficiently large support face for the rear end of the punching die 22 results.

It is furthermore understood that, in place of a single transverse pin 14 for aligning the punching die 22 and the die plunger 12 with respect to the guide bushing 10, two separate transverse pins could be used in order to align the punching die 22 in relation to the die plunger 12 on the one hand and, on the other, to align the latter in relation to the guide bushing 10.

All above mentioned embodiment variations have the advantage that it is possible to achieve the advantages described by means of a very small punching die as the only easily exchangeable wear element.

Although the invention has been described with respect to preferred embodiments, it will be appreciated that the invention is capable of numerous modifications and variations apparent to those skilled in the art without departing from the spirit and scope of the invention.